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L. O. HOWARD, Chief

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THE EUROPEAN HORSE-RADISH WEBWORM.[1]

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CONTENTS.

	Page.		Page.
Introduction	1	Food plants	8
Description	2	Natural enemies	9
Distribution	4	Control	9
Notes on occurrence and habits	5	Summary	9
History in North America	8	Literature cited	10

INTRODUCTION.

Horse-radish grown in the northern United States and in Canada is subject to attack by a medium-sized caterpillar known both as the purple-backed webworm and the horse-radish webworm. Like so many of our insect pests, this species is of foreign origin and gained entrance into this country many years ago, but until recent years it has not been known to spread materially. While favoring horse-radish, it is also known to attack turnip and cabbage, and after feeding on the lower surface of the leaves sometimes webs them together near the ground. When abundant it attacks the stalks, even down to the roots.

Prior to the year 1919, when this webworm was first discovered in injurious numbers in Virginia near the District of Columbia, reports of injurious occurrences were nearly all confined to the maritime Provinces of Canada, although attack had been noted occasionally in Massachusetts, New York, New Jersey, and Wisconsin. The insect has been known to occur in the District of Columbia for several years, but heretofore it has been somewhat of a rarity.

This species makes the third specific enemy of horse-radish inhabiting North America, the other two being the introduced horse-radish flea-beetle (*8*)[2, 3] and the native horse-radish webworm (*9*).[4]

[1] *Evergestis straminalis* Hübner; order Lepidoptera, family Pyralidae.
[2] *Phyllotreta armoraciae* Koch.
[3] Numbers in parentheses (italic) refer to "Literature cited," page 10.
[4] *Plutella armoracia* Busck.

Two other webworms affect horse-radish in the United States, both introduced from abroad, namely, the imported cabbage webworm (*7*)[5] and the diamond-back moth (*10*).[6]

DESCRIPTION.

THE MOTH.

The moth of this species is rather bright ocher yellow and the forewings are traversed by two irregular lines dividing the wing into thirds of nearly equal width. Near the tip of the forewing is a conspicuous lighter spot and another larger rounded one near the middle of the anterior border. Directly outward from this latter there is an angular 8-shaped spot. The wing expanse is about 1 inch (25 mm.) and the length of the body a little less than half an inch (10 mm.). This moth resembles in general contour the related *E. rimosalis* Guen., but may be readily distinguished by the characters given and with the aid of the accompanying illustration (fig. 1). In some individuals the outer edge of the forewing is much darker than in others, darker even than in *E. rimosalis*.

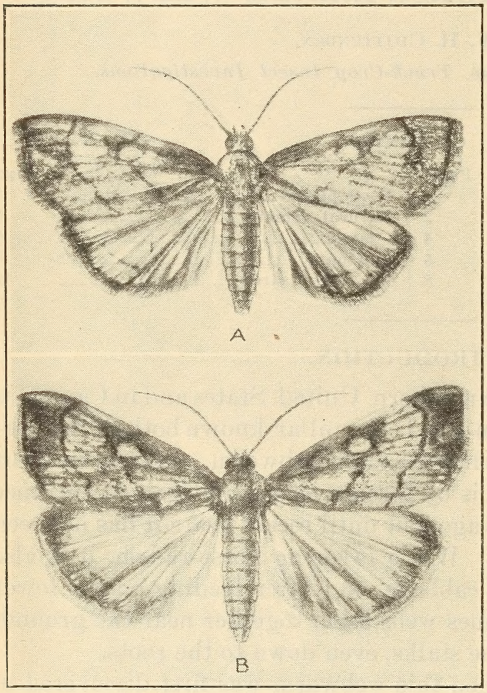

FIG. 1.—European horse-radish webworm (*Evergestis straminalis*): *a*, Moth, normal form; *b*, moth, dark form. Twice natural size.

The following more technical description is after Meyrick (*5*, *p. 424*):

Fore-wings pale ocherous-yellow, sprinkled with dark brown, veins posteriorly dark brown; lines dark fuscous, first angulated above middle, angularly indented above angle, second unevenly curved; an angularly 8-shaped discal spot, outlined with dark fuscous, touching angle of first line; a cloudy dark fuscous subterminal line, forming above middle a strong dark suffusion inclosing a pale terminal spot. Hindwings prismatic yellow-whitish; traces of a dark posterior line; termen narrowly dark fuscous.

[5] *Hellula undalis* Fab.
[6] *Plutella maculipennis* Curt.

THE EGG.

The eggs (fig. 2) are deposited in compact masses containing from half a dozen eggs to a score or more. Both the egg and the mass are difficult to describe, the individual egg being scarcely separate from the mass.

The individual egg is irregular oval, the mass being arranged more or less irregularly, as in the case of a honeycomb. The color is a little brighter green than the leaf on which it is deposited and each egg is surrounded by an irregular ring of yellow spots arranged in chains numbering about 12 to 18 to an egg. There is strong overlapping, so that an egg mass resembles, very imperfectly, a mass of fish scales. The surface is finely reticulate and divided into shining, minute, irregular areas much like the surface of leather. The diameter is about 0.8 mm.

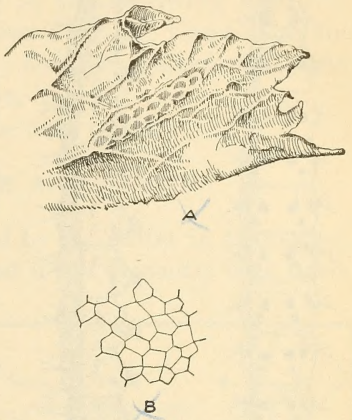

FIG. 2.—European horse-radish webworm: *a*, Egg mass *in situ* on leaf, three times natural size; *b*, section of surface of egg, highly magnified.

THE LARVA.

In the penultimate stage the larva (fig. 3) presents an appearance somewhat similar to the full-grown larva as regards the arrangement of the piliferous tubercles, but the form is more slender and the body tapers more at each end (the head being proportionately much smaller). The general color of the upper surface is purplish and has the peculiar appearance of being split through the middle, due to a wide pinkish longitudinal band separating the two parts between the rows of piliferous tubercles. The thoracic and anal plates are correspondingly smaller and faint yellowish brown.

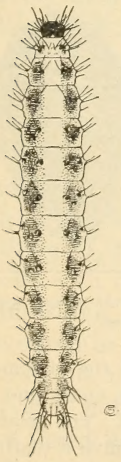

FIG. 3.—European horse-radish webworm: Penultimate stage of larva. Much enlarged.

THE FULL-GROWN LARVA.

The full-grown larva (fig. 4) is elongate, cylindrical, about six times as long as wide, and tapers slightly toward each extremity, especially posteriorly. The general color is variable, generally either dull or shining dark slate gray above, sometimes faintly bluish. The lower surface is pale greenish yellow or yellowish, and the sides are marked with a narrow stigmatal line, orange about the spiracles and whitish or yellowish near the sutures. The head is shining jet black, faintly but distinctly separated, the delta-shaped middle portion longer than wide. The thoracic plate is piceous, the middle third or fourth paler, sometimes yellowish. The abdominal segments are without trace of transverse stripes; the piliferous tubercles are large and black; two pairs on the first two segments, the remainder arranged in groups of three, each side forming a triangle. The anal plate is small, dull pale brownish. The sides have a row of substigmatal tubercles, one or two on each segment and another row midway between these and the legs; the legs are greenish or yellowish.

The length is 18 mm.; the width, 3 mm.

The larva has been described as purple, but the mature larva exhibits no evidence of this color in life. When preserved in alcohol there is a reddish and sometimes slightly purplish tinge.

The larva can be readily separated from that of *E. rimosalis* by the complete lack of transverse striation and by the black head.

When about to transform to pupa, the larva forms, usually at or near the surface of the ground, a substantial cocoon (fig. 5), which is evidently well coated on the exterior with a viscid substance to which particles of sand become attached. These cocoons are large in comparison to the pupa and irregular short oval in shape.

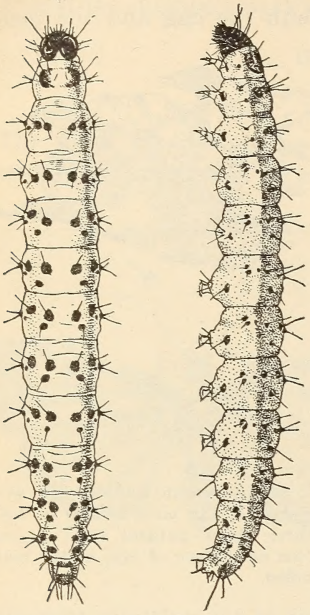

FIG. 4.—Full-grown larva of European horse-radish webworm: *a*, Dorsal view; *b*, lateral view. Four times natural size.

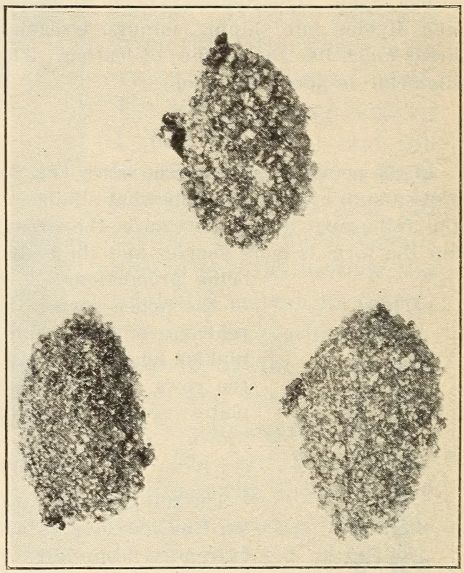

FIG. 5.—Cocoons of European horse-radish webworm. Much enlarged.

THE PUPA.

The pupa (fig. 6) is of robust form with long wing cases extending to the antepenultimate segment of the abdomen. It is widest below the middle across the wing cases and at its widest part is three-eighths as wide as long. The general color is brownish yellow, but the wing cases have a distinct greenish tinge. The eyes are large and black. The last abdominal segment is prolonged and unarmed.

The length is 8 mm.; the width, 3 mm.

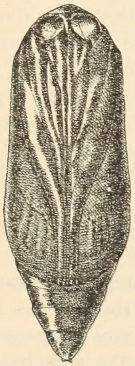

FIG. 6.—European horse-radish webworm: Pupa. Six times natural size.

DISTRIBUTION.

Evergestis straminalis is native to the Old World, where it is found in Central Europe and in Great

Britain and Ireland. In Canada it has been reported from Cape Breton Island, Little Bras d'Or, Old Chelsea, Quebec, and Nova Scotia. In the United States it has been established for many years at Cambridge, Mass. Specimens are in the United States National Museum and it is noted as occurring in the following localities: Albany, Rochester, Kendall, N. Y.; Chester, N. J.; Cambridge and North Adams, Mass.; New Hampshire; northern Illinois; Madison, Wis.; Washington, D. C.; and Arlington, Va.

The known distribution is shown in the map (fig. 7).

NOTES OF OCCURRENCE AND HABITS.

The moth of this species was collected by the writer in September, 1898, at Washington, D. C., showing that it has evidently been established in this vicinity for several years, presumably feeding on horse-radish, though in small numbers, since it did not attract attention until 1919.

The records of the Bureau of Entomology show that the species was received July 27, 1903, from Dr. E. P. Felt, Albany, N. Y.

June 21, 1913, larvæ were observed attacking horse-radish at Chester, N. J., by H. O. Marsh. Larvæ under observation on June 30 burrowed into the soil and spun cocoons. The first of these transformed to pupa July 23, and the moth issued August 13, making the pupal period in this case 21 days.

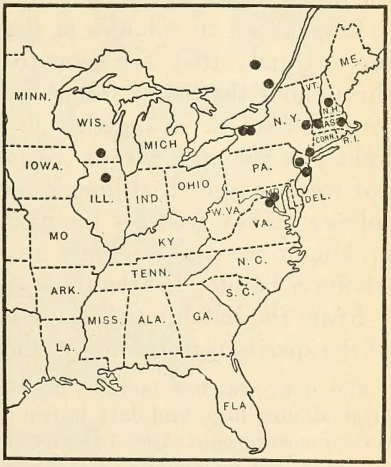

FIG. 7.—Distribution of European horse-radish webworm.

June 14, 1914, specimens were received from Mr. Francis R. Foxcroft, with report that the larvæ were injuring turnip and radish at Cambridge, Mass., and that the leaves had been almost entirely devoured in that vicinity.

July 15, 1919, William H. White, Bureau of Entomology, observed larvæ on horse-radish at Arlington, Va., and later the writer observed this insect in the same locality.

Eggs which were deposited July 17, 1919, hatched July 24, and the larvæ from this lot, feeding on horse-radish leaves, began to transform to pupæ August 5. In this case the egg period was 7 days. The temperature was normal for the season, 64° to 91° F., and averaging 77° F.

By the third week of July, 1919, all moths from larvæ in confinement had issued from the cocoons; but another lot containing many

individuals living in a rearing cage in the open descended into the earth and when pupal cases, which were not far from the surface of the earth, were examined much later, it was found that the larvæ were unchanged and that no moths had issued.

During October it was observed that larvæ were again infesting the same horse-radish patch where first discovered at Arlington, Va., and by October 17 considerable injury had been done to the foliage, quite as much showing at this time as that done by the harlequin cabbage bug during the season. Where the leaves were dead and dry and were more or less loosely matted together, the larvæ were invariably found; indeed, they infested the entire patch from one end to the other. Larvæ were rapidly growing to maturity at this time, feeding sparingly and sluggishly during the cool weather which prevailed when under observation in the field. Characteristic injury to the lower leaves as inflicted in midseason is shown in figure 8.

Larvæ feed in colonies at first, but with the period of approaching maturity they are soon to be found singly and well scattered throughout the field. Some few are protected by white silken webs joining two leaves together or by drawing a single leaf somewhat lightly at the middle near the midrib. The great majority, however, are freely exposed, although sheltered from the sun by overhanging foliage. They feed for the most part near the midribs and near the middle of the plant, seldom near the outer ends, which as the season advances become for the most part dead and dry.

From the hatching of the larva until its maturity the life history of the species is well told by Buckler (*4*) as follows:

> The newly-hatched larva is green, and rather transparent, with a flattened black shining head and dark brown neck-plate, and on the body can just be discerned most minute black dots and hairs; after eating out little pits and channels from the cuticle, causing transparent blotches on the leaf for about five or six days and acquiring more colour, it becomes of a very pale watery-green as it lays up to moult.
>
> After the first moult it eats holes quite through the leaf, and its ravages are very perceptible; its head is black, the back dark green, the belly pale watery-green, the sides of the shining neck-plate dark brown, while the middle of the plate is of the same green colour as that of the back, the wart-like spots are of the ground colour but have dark brown centres bearing single hairs, and a pale ring is at the base of each spot.
>
> Soon after the second moult it is very dark on the back with a deep and subdued blackish olive-green colour, while the belly has a much lighter tint of the same, these are separated by a spiracular stripe of bright yellow, the head, the side margins of the neck-plate, and the warty spots on the upper surface are shining black, on each side of the back are two very fine and much interrupted series of white linear dots, less broken on the second segment to the end of the fourth than on the others, the warty spots on the ventral surface are of the ground-colour, having dark olive-brown centres.
>
> Directly after the third moult and for a day or so the ground-colour of the larva appears perfectly black, which enhances the brillancy [brilliancy] of the

broken white lines and the yellow spiracular stripes, but by degrees, after it settles down to feed again and grow, the black skin expands and the ground-colour of the back becomes more and more green until it is again of a blackish olivaceous-green, when the length ranges from 13 to 16 mm.

FIG. 8.—Horse-radish leaf skeletonized by the European horse-radish webworm.

It now consumes a great quantity of food and the plump skin begins to shine a little; at the end of about ten days it attains full-growth.

HISTORY IN NORTH AMERICA.

The species was described by Hübner from Europe in 1792 (*1*) and must have been introduced into this country, probably with its favorite food plant, at an early date, since it came under the observation of Harris in 1841 (*3*, *p. 322*). In Harris's notebooks appear the following memoranda:

> Oct. 30 and Nov. 1, 1841. Found on leaves of horse-radish.
>
> They eat large holes out of leaves, leaving finally only the veins untouched. They live beneath the leaves, stretched out by the sides of the midrib. They creep regularly, not haltingly, and move pretty fast. When alarmed or disturbed they curl quickly, and lose their hold, and fall to the ground. . . . Found the same on turnip leaves, Oct. 20, 1844, their ravages very considerable.

This account includes a description and a reproduction of a sketch of the larva, which are omitted here. Walker's description appeared in 1859 (*2*, *p. 756*) and was based on specimens from the United States and Nova Scotia.

An account of this insect by William Buckler (*4*) appeared in 1882. Not knowing the insect's food plants, but judging that it would live on Cruciferae, he placed the eggs on different plants. In confinement the larvæ fed freely on *Barbarea vulgaris*, *Sinapis arvensis*, and *Cardamine amara*. Larvæ molted three times, as follows: The first molt occurred August 8 to 10, the second August 17 and 18, and the third August 24 to 27. By September 29 all were full-fed and were inclosed in cocoons of earth. The moths began to issue June 20 of the following year, continuing emergence up to July 27. Buckler describes the egg, stating that it hatched in 8 days, the newly hatched larva, the different molts, and the cocoon.

Many years after Harris's first account, Dr. James Fletcher (*6*, *p. 231*) furnished the second account, and writes in 1904 that occasional reports had been received at different times for 10 years of attack on cabbage and turnip in the maritime Provinces of Canada. The caterpillars were described as congregating on the crowns of turnips and eating cabbages into the roots as well as consuming the leaves. Whole fields of cabbage and turnip were destroyed at Cape Breton Island. The larvæ were described as starting under the leaves just out of the ground and mining their way up to the head, tunneling it hollow. Injury was also reported to cabbage in 1903 at Old Chelsea, Quebec, Canada, and an original description of the larva was included.

In 1918 a popular account of this species was published by Messrs. Crosby and Leonard (*11*, *p. 19–20*).

FOOD PLANTS.

Harris recorded *Evergestis straminalis* on horse-radish and turnip, and Fletcher noted attack on these plants and on cabbage in Canada.

In Europe the species has been recorded as feeding in confinement on wild plants of the genera Barbarea, Sinapis, and Cardamine.

NATURAL ENEMIES.

This species is apparently unusually free from natural enemies, judging by the experience gained from two years' study in the vicinity of the District of Columbia. A single parasite, *Bracon montrealensis* Morrison (Chttn. No. 6076[01]), determined by A. B. Gahan, was reared from the larva of this species September 6, 1919, at Arlington, Va.

CONTROL.

It is evident, considering the fact that only one natural enemy of this species is known, that little can be expected from natural agencies of control. The arsenates of lead and lime and arsenite of zinc will all undoubtedly operate against the larva with equal value when applied for other cabbage worms. Underspraying is necessary, because of the habit of the larva of feeding mostly in concealment near the base of the plant. Hand-picking, if carefully carried out, is also of value when the species does not occur in too large numbers, as in the case of the infestation at Arlington, Va.

In the occurrence of this species on horse-radish, it is more difficult of control than on cabbage and other annuals. On such crops fall and spring plowing and frequent cultivation would undoubtedly be of great service in destroying the insect in its pupal cases, which are usually at or near the surface of the ground. Plowing could not be practiced in beds of horse-radish, and here many of the pests would survive the winter unless a spray were applied, which should be done in case of severe infestation.

SUMMARY.

Horse-radish, and less often turnip and cabbage grown in the northern States, are subject to attack by the European horse-radish webworm (*Evergestis straminalis* Hübner), a greenish caterpillar with reddish or purplish tints, measuring, when full-grown, about three-fourths of an inch in length.

It feeds on the lower surface of the leaves, which it frequently webs together near the ground, and also attacks the stalks.

This insect came originally from Europe, and has recently made its appearance on horse-radish in Virginia. It is known to occur from New England westward to Wisconsin.

It passes the winter as a larva in an earth-covered pupal case near the surface of the ground and the moths appear some time in May. In Virginia the eggs hatch in 7 or 8 days, and the larvæ begin by

feeding on the leaves, when abundant attack the stalks, and attain full growth in about 3 weeks. They then transform to pupæ, and about 3 weeks later produce another brood of moths, making an approximate life cycle of 7 or 8 weeks, depending on temperature. At least two generations a year are produced in Virginia.

This webworm may be controlled by arsenicals and by hand-picking on horse-radish and, more readily on other crops, by fall and spring plowing and frequent cultivation.

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